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ABSTRACT

This document examines a system for integrating reading into the earth science curriculum. Such topics are examined as to why the earth science curriculum can benefit from reading program participation, competency based instruction in content courses, reading/thinking competencies in earth science, assessing reading competency in earth science, diagnostic and instructional process, prerequisite activities, instructional strategies, conceptualization of reading, remediation through earth science, and reading objectives in content courses. It is concluded that student, parent, and teacher reaction to System for Integrating Reading Into Content Areas (SIRCA) has been positive, as has students' growth in earth science. SIRCA has brought the reading specialist into meaningful participation within the mainstream of school life. (TS)

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SIRCA

SYSTEM FOR INTEGRATING READING INTO CONTENT AREAS

An Earth Science Application

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SIRCA

SYSTEM FOR INTEGRATING READING INTO CONTENT AREAS

An Earth Science Application

Recognition of the need to integrate reading instruction into content area courses is nearly universal among reading specialists, and growing among content teachers and administrators. Current national trends to mainstream LD and handicapped, to reject tracking in favor of heterogeneous class groupings, to criticise schools for apparent decline in students' basic skills, have increased receptivity to programs which involve reading specialists within content courses.

Can (should) reading remediation be attempted in content courses? Where are the boundaries between reading instruction to develop a tool for achieving content objectives, and reading remediation which is traditionally the responsibility of the specialist? Who should (can) (will) do what?

This paper offers some operational solutions to these and other practical problems of content-area / reading program design. SIRCA (System for Integrating Reading into Content Areas) is described; an ongoing SIRCA program in earth science is considered.

WHY EARTH SCIENCE?

Earth science is an entry level science course combining geology, metereology, oceanography, and astronomy. Students are predominantly ninth graders, with a broad range of ability and interest. The textbook is difficult for many students, however all must take either this course or biology for the required high school science credit.

Reading program participation in earth science has several advantages. (1) Nearly half of incoming ninth grade students elect earth science. SIRCA in earth science enables these students to be screened for reading disability early in their high school careers, and to receive appropriate reading instruction in an important highly motivating setting. (2) The failure rate in a difficult course is reduced. (3) Science courses are ideally suited for students to develop language and reasoning capabilities.

Science courses offer contact experience in the laboratory for the language being used. Laboratory work therefore can be an excellent vehicle for developing language facility (even for those students with serious deficiencies) <u>if</u> written and spoken language tasks are integrated into the laboratory situations, and <u>if</u> the reading, writing, and reasoning tasks students are expected to perform are appropriate for their own levels of competency.

To identify the necessary reading / reasoning competencies in earth science, and to incorporate the activities to develop these competencies are major purposes of SIRCA in earth science.

COMPETENCY-BASED INSTRUCTION IN CONTENT COURSES

For a content area teacher to care about reading instruction, it is necessary for him / her to conceptualize reading instruction as something more fundamental to science than lists of isolated, mechanistic skills and how-to-read-science types of lessons.

Competency-based instruction provides both the conceptual base and the methodology for integrating reading and content instruction within a course such as earth science. Summarized briefly, competency-based instruction begins with an analysis of the task, and an identification of the skills students need to perform the tasks. Students' skills are evaluated, training needs determined, objectives formulated, instruction implemented, and learning evaluated. (Davies, 2.) The focus, activities, and rationale are firmly rooted in the content of the course.

Competency-based instruction differs from traditional methodology in that requisite abilities are not assumed of students, rather developed with them. An earth science learning situation is considered effective by the standards of competency-based instruction if it develops whatever skills students lack, but need, to fulfill the course objectives.

Inevitably many of the students' training needs involve information processing (ie. reading) abilities, and some of these instructional needs are on a very basic level. "Remedial" instruction cannot be distinguished from "developmental" instruction in this context.

READING / THINKING COMPETENCIES NEEDED IN EARTH SCIENCE

Certain general characteristics of earth science information can be noted.

The laboratories consist of largely hands-on, discovery type experiences, and field study, supplemented by the use of "slide show field trips" to observe phenomena that are not locally available. However the nature of topics studied in laboratory requires the frequent use of models (sand, rocks, water, plastic models, beads, smoke and CO2 in cloud chambers, topolcgical maps, etc.) to simulate events that cannot be manipulated directly. From these simulations students must visualize formations and processes, many of which they have not seen in real life.

Charting, graphing, hypothesizing, and concluding from observations are ongoing earth science activities. Time acquires a new dimension - geologic ages - as causes which occurred eons ago are inferred from physical earth features. Processes are described, hypotheses are proposed and tested on laboratory models. There is of course a whole new vocabulary to be learned. If reading is in fact "...the mental process of reconstructing the experiences behind language," (Stauffer, 8) the reading requirements of earth science are enormous.

The American Geological Institutes book Investigating the Earth and the accompanying laboratory materials comprise the curriculum of this course. The average readability using the Fry formula is 9th grade level, although the range of samples included 7th grade to college.

These figures however understate the difficulty of Investigating the Earth. The writing is compact and fact-loaded. The syntax is sometimes awkward and difficult. The explanatory vocabulary, ie. the words assumed to be known by students and used to explain earth science concepts, is also very difficult.

The organization of ideas within the book is not readily apparent, despite the use of headings. Inferential and deductive writing patterns are interspersed throughout; outlining is difficult.

The outstanding features of the text include the laboratories, which are concrete and imaginatively designed to teach basic science concepts. Drawings and photographs, sometimes side-by-side, are effectively used.

Students must use the text to succeed in the course. They must read diagrams, charts, pictures and graphs in close detail for important information that is not available through any other means. Students must follow complicated directions step-by-step in laboratory, and perform sophisticated reasoning tasks.

No commerically prepared exercises, or quick lessons, can develop the needed competencies. The reading specialist can clarify the instructional problems chapter by chapter, help to devise strategies to guide students through, and provide needed support activities. Inevitably this entails a continuing close involvement within the course itself.

ASSESSING READING COMPETENCY IN EARTH SCIENCE

Students are pretested by the use of: (1) a cloze reading test (every 10th word deleted) prepared from an early chapter that has not previously been read; (2) a cloze listening test (same test, fresh copy) read to the students as they read along; (3) a spelling test (10 earth science terms from a chapter previously read.)

TASK, Stanford Tests Academic Skills: Reading, language arts, and mathematics subtests are administered to all 9th and 10th graders in the school. (TASK, 9) TASK scores provide part of the data base through which the effectiveness of SIRCA programs will be evaluated. TASK scores are not utilized in planning for earth science classes.

Cloze tests are scored for exact word replacement, with no penalty for misspelling. Reading levels are determined according to these criteria: independent reading level, 60% or more correct; instructional reading level, 45-59% correct; frustration reading level, 44% and below. (Bormuth, 1) An additional group, designated high risk, includes scores of 30% or less correct.

Table 1 summarizes the pretest scores.

Table 1

SIRCA
SUMMARY of PRETEST SCORES

Level	CLOZE READING			CLOZE LISTENING 10+ above READING		SPELLING 60% correct or less		
	Number	Percent	Average Score	Number	Percent Within Level	Number	Percent Within Level	Average Score
HIGH RISK Frustration	30	23%	22*	11	36%	18/27	66%	51
	37	27%	39	2	5%	11/25*	31%	72
Instructional	31	30%	52	1	3%	6/31*	19%	77
Independent	25	20%	66	1	4%	4/24*	16%	83
Total	123		44					
Range	4-80* *Excludes 2 refusals			4-76		0-100 *Students for whom both scores are available		

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The test scores suggest that most students need considerable preparation to read this book. Half of students are frustration level readers; some students appear unable to read the text. Comparisons of the test scores provides useful diagnostic information.

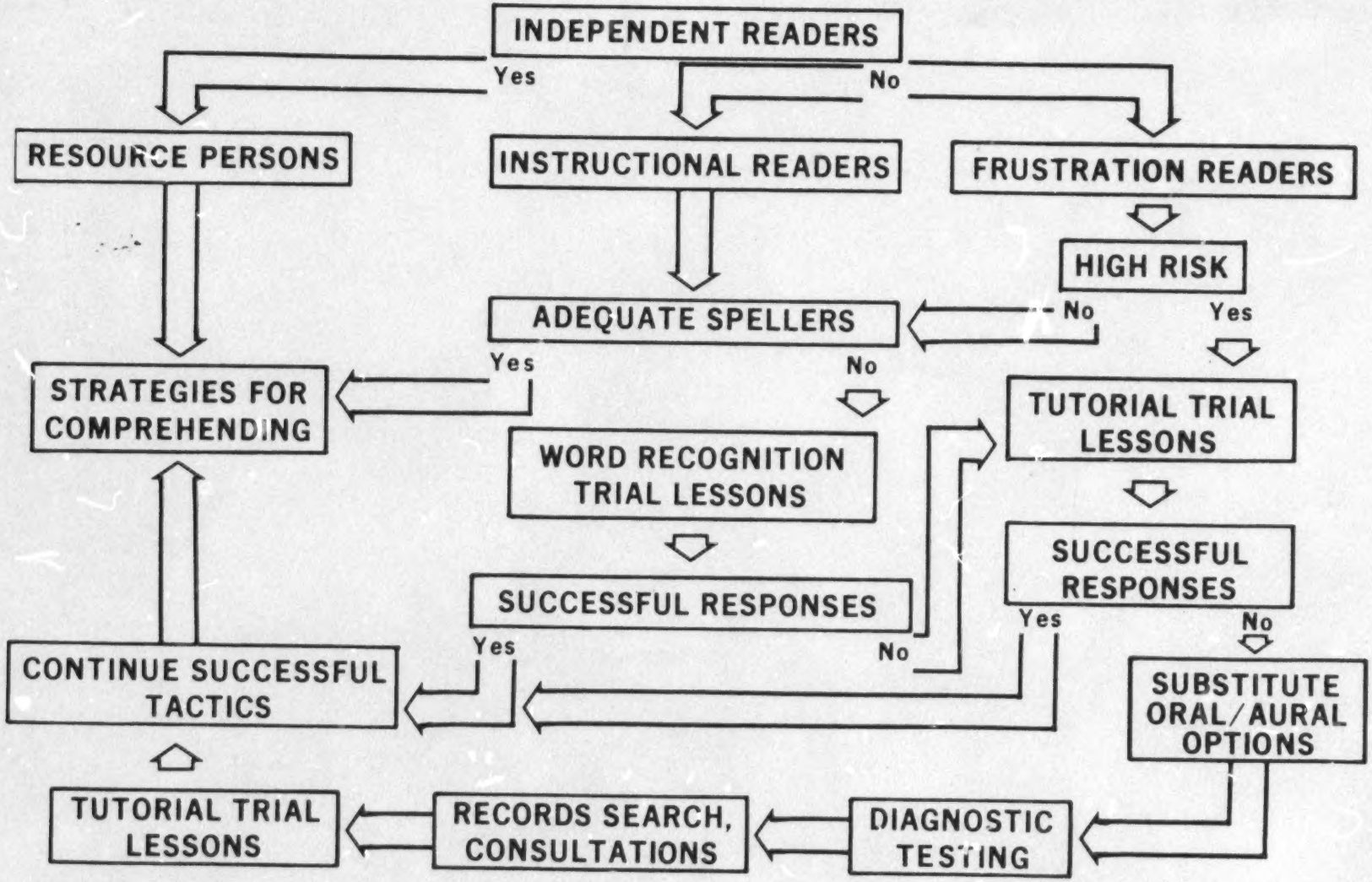
The association of poor spelling and higher listening scores for high risk students suggests the need for word recognition instruction for those students.

Listening test scores are similar to reading scores for most students. This is interpreted to mean that the difficulties of reading this text are related to lack of understanding the language and meaning for most students, rather than faulty word recognition alone. Several students with 20 point differences listening over reading are notable exceptions.

Table 2 outlines the initial diagnostic and instructional process.

Table 2

SIRCA
INITIAL DIAGNOSTIC and PRESCRIPTIVE PROCESS
(Administer cloze reading, listening, and spelling tests)



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DIAGNOSTIC AND INSTRUCTIONAL PROCESS

This process consists of a succession of decisions which sort students according to their most immediate instructional need. These judgements are verified, corrected, and refined in tutorial trial lessons. Individuals may be told in general terms of their particular strengths and weaknesses, but of course no groupings are designated in class; any groupings that occur for a particular trial lesson are for that day only. Instructional groupings are constantly shifting as the course progresses; problem readers are not publically identifiable.

Independent readers are utilized within class as resource persons. Sometimes they are given leadership responsibility within their laboratory groups; other times they prepare guides and visuals for use in class.

The high risk category is useful for two reasons. First, it facilitates immediate teacher attention to the needs of the poorest readers so that they can become involved in appropriate instruction before failure can happen. Secondly, it clarifies a serious problem with cloze testing in content area textbooks.

The term "frustration level' suggests, and is often interpreted to mean, that a student with a cloze score below 45% cannot read that particular book. In practice this is not always true. Many teachers accept synonyms as correct in an attempt to make the cloze scores more dependable predictors of student ability to read a given book.

A more useful interpretation is that the cloze scores place students along a continuum of difficulty which they will experience when reading the book. As the scores are lower, the amount of instructional support students will need for effective reading increases. In practice SIRCA teachers observe that most students, including frustration level readers, can learn to use the text, if they are given adequate ongoing support. The truly frustrated reader, who is unable to cope without extraordinary measures, is likely to have a very low cloze score.

Inadequate spelling (60% correct or less) is the basis for determining who has word recognition problems. Poor word recognition can also be inferred from higher listening scores for some students. Spelling has proved to be the more reliable indicator, because it shows students with word recognition problems who are also experientially lacking and hence unable to do much better when listening than reading.

Tutorial trial lessons utilize the content that is current in class, and are diagnostic in nature. They may be taught by the specialist or the classroom teacher. Initial trial lessons enable positive identification of students who need limited course objectives and further individual diagnosis and referral. As the course progresses, tutorial lessons become another vehicle for ongoing remediation. The specialist needs to teach them regularly to keep relevant; the classroom teacher needs them to keep in touch with his reading - disabled students.

Strategies for comprehending refer to those mental activities one must do to understand, organize, work with earth science information. Acquiring these strategies is the ultimate objective for all students.

Competency-based methodology is applied throughout the course. Specific training needs, objectives, and instructional activities are developed out of the earth science content, and subject-centered evaluations shape the ongoing instructional program. The initial tests are important for what they have revealed about individual learning styles, and as a basis for posttest evaluation of the effectiveness of the system.

PREREQUISITE ACTIVITIES

Table 3 indicates certain activities which are essential to implement SIRCA within a course. Initiating the planning process is a specialist responsibility. However shared planning must pervade all aspects of the course if reading / thinking processes are to be clarified and taught simultaneously with the course content. A mutual commitment to competency-based methodology, an openness to innovation, and a high level of trust are necessary. The specialist must be welcome in class.

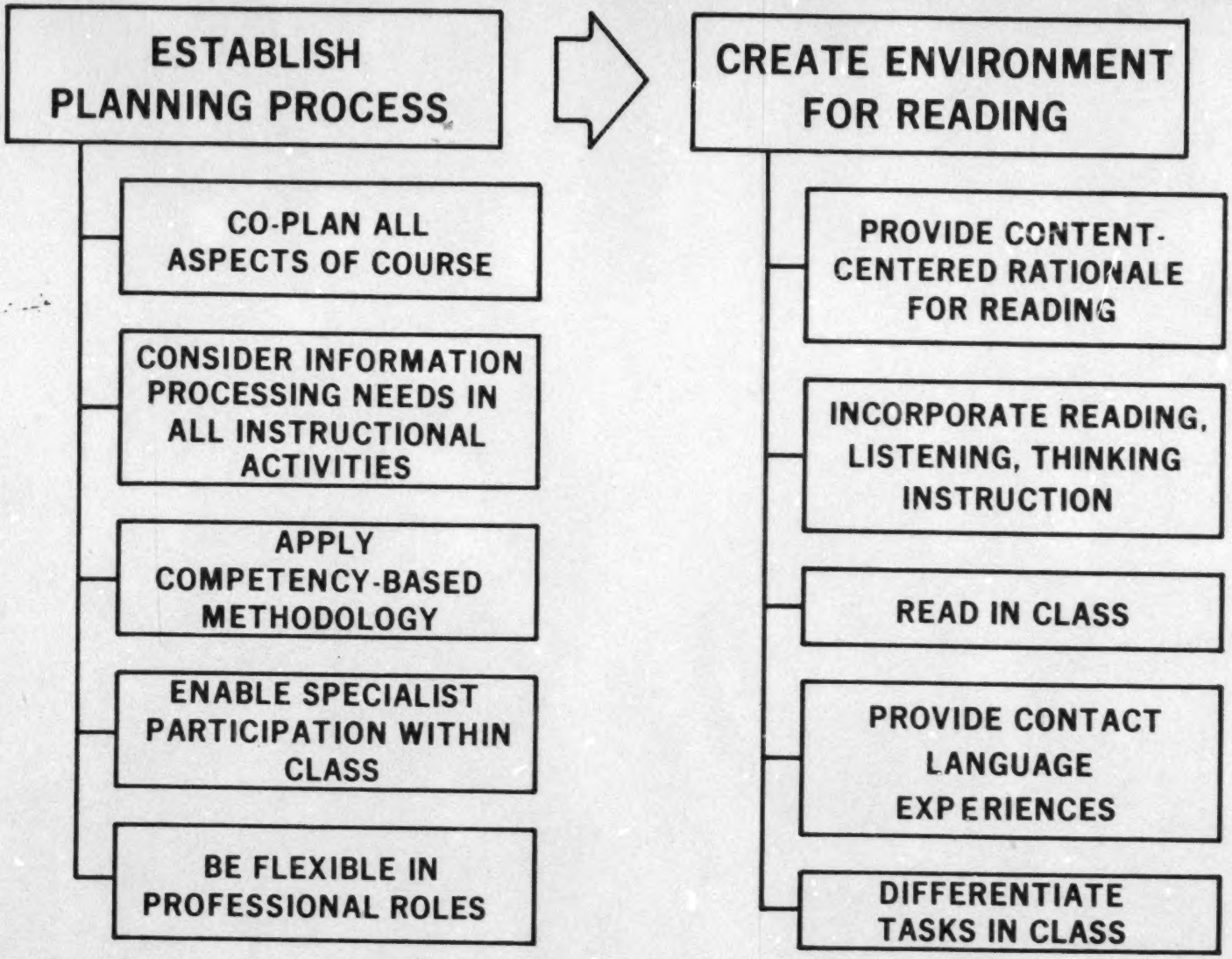
A classroom environment in which reading is valued, needed, and practiced is of course necessary for SIRCA, and cannot be assumed to exist. Establishing purpose for reading is primarily a classroom teacher responsibility. So also is the decision to differentiate instruction and to provide contact experiences with the language of the course. However the specialist provides leadership, techniques, and help in class to implement all of these.

If agreement cannot be reached to implement these activities - if a classroom teacher, for example, is unwilling to co-plan or to differentiate instruction - SIRCA cannot be established.

Table 3

SIRCA

ESSENTIAL ACTIVITIES FOR IMPLEMENTING the SYSTEM


ESTABLISH PLANNING PROCESS
CO-PLAN ALL ASPECTS OF COURSE
CONSIDER INFORMATION PROCESSING NEEDS IN ALL INSTRUCTIONAL ACTIVITIES
APPLY COMPETENCY-BASED METHODOLOGY
ENABLE SPECIALIST PARTICIPATION WITHIN CLASS
BE FLEXIBLE IN PROFESSIONAL ROLES
CREATE ENVIRONMENT FOR READING
PROVIDE CONTENT-CENTERED RATIONALE FOR READING
INCORPORATE READING, LISTENING, THINKING INSTRUCTION
READ IN CLASS
PROVIDE CONTACT LANGUAGE EXPERIENCES
DIFFERENTIATE TASKS IN CLASS

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INSTRUCTIONAL STRATEGIES

SIRCA in earth science utilizes four major instructional strategies.

(1) Bring more planned verbal activity into the earth science laboratory, so that it is truly a language-experience situation, not just experience. Verbal tasks might be in the form of reasoning guides which add intermediary logical steps between the directions in the book and the final inferences the students are asked to make. Flash cards, taped reinforcement activity, prescriptive one-to-one interactions with certain individuals (Example: "Use 'profile' in a sentence which has to do with your soil sample.") are some of the many techniques used.

(2) Use of selective reading techniques, not only for the important reasons of reading to grasp structure etc., but also to reduce the amount of reading that has to be done from the text by some students. Previewing with a guide, and / or reading certain key sections reduces the concept load yet makes part of the text accessible to students who cannot cope with the full text. Any reading from the text by severely disabled students requires careful prescriptive planning, and the use of guides tutorial lessons, and other instructional supports.

(3) Devise and teach strategies for comprehending, ie. the activities, the thinking steps, the relating one must do to get meaning and information from earth science materials. The specialist and teacher work out these strategies best by considering their own step-by-step logical approach to understanding the particular concepts or relationships being taught.

(4) Develop and use guides to organize student response to the material being read; develop instructional options and reinforcement activities both for all-class use and for prescriptive use by certain students. All options and guides are prepared from earth science textual materials.

CONCEPTUALIZATION OF READING

Reading is conceptualized in its broader aspects as thinking and information processing. The models of reading and philosophies of instruction which SIRCA teachers find most useful are these:

Reading is the process of reconstructing the reality behind words. "...reading is a thinking process; ...people can be trained to read critically and reflectively." (Stauffer, 8)

Reading is the search for relationships, and the building of structures out of these relationships. (Henry, 6)

Hypothesizing, anticipating meaning, risk-taking are important when reading, require student self-confidence, and can be facilitated by teachers. (Goodman, 4; Stauffer, 8)

Word attack techniques utilizing context, structure, and phonetic elements are important.

An instructional framework for reading can be found within content courses. The use of guides and structured overviews to direct students' reaction when reading are effective to teach students how to comprehend. (Herber, 7)

SIRCA teachers find that, with a content-centered approach, the number of separate reading skills diminishes. A consistent approach emerges that is uniquely suited to earth science information. It is pragmatic and relevant, because it is rooted in the daily purposes of the course, in the overriding effort to find meaning in earth science.

REMEDIATION THROUGH EARTH SCIENCE

Table 4 shows the activities for remediating student deficiencies in reading. Limited objectives are chosen for students unable to achieve the usual course objectives. The content area teacher selects what is vital to later course work, and to the integrity of the course.

The specialist has primary responsibility for initiating prescriptive instruction, and for guiding the preparation of appropriate reinforcement activities and test procedures. The actual writing of guides and lesson plans is shared, and becomes an ongoing practicum in diagnostic teaching for the classroom teacher.

Implementing remediation is shared. Prescriptive lessons and one-to-one prescriptive interactions are done by teacher, specialist, and others. Ideally the specialist team teaches in class once a week. Various mechanical aids are utilized to reinforce skills, to permit listening - reinforced reading of the current earth science content. Parent volunteers are organized to help make instructional materials, and to assist in class.

Some of the concerns which caused uncertainty as SIRCA was initiated seem now to be unfounded. Carefully kept diagnostic records and the recurring patterns of earth science information permit a surprising degree of repetition of basic skills teaching when it is desirable. Also, inasmuch as it is impossible to include all of the

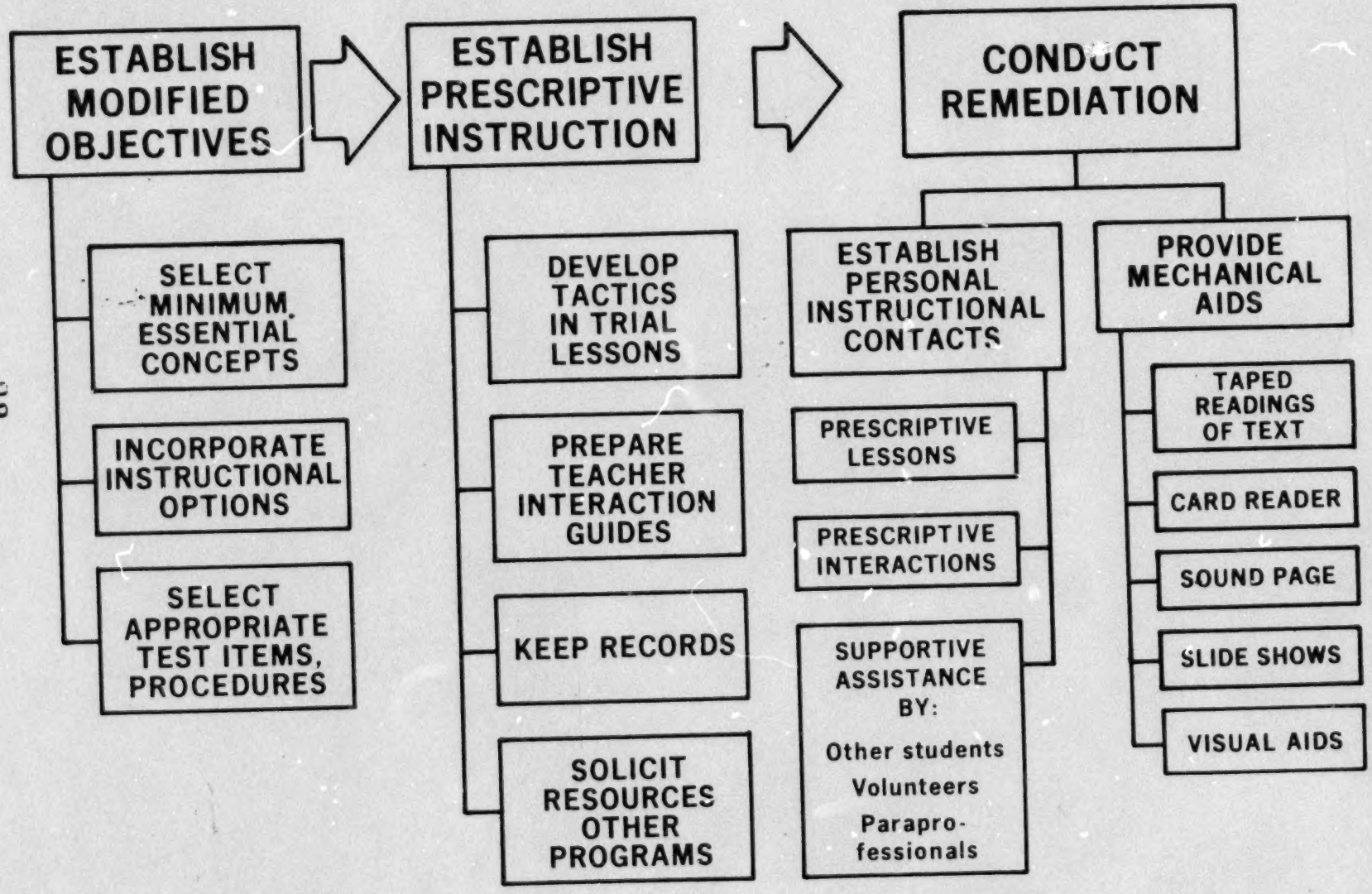
possible objectives within a unit, sometimes objectives for a particular student can be chosen for reading priorities as well as earth science ones, to assure adequate sequencing and reinforcement.

Read-along-listening has not fostered dependency. It is not now chosen by students who can read the book on their own, although in the beginning of the year many good readers tried it out. There are practical limitations to the numbers of activities which can be pre-recorded, so that inevitably reading without listening-along occurs often.

The SIRCA earth science teacher believes that little classroom time is "lost" to reading instruction, primarily because earth science and reading objectives are being simultaneously achieved. However credibility can be a real problem, particularly in the case of a content supervisor who is rigidly traditional, who views reading instruction narrowly, or who does not understand what is happening.

Table 4

SIRCA
ACTIVITIES FOR REMEDIATION OF HIGH RISK READERS



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READING OBJECTIVES IN CONTENT COURSES

There are many workable reading objectives within content area courses, requiring varying expenditures of school resources. A taxonomy of possible objectives appears in Table 5.

The objectives lower on the taxonomy, which include motivating reading, differentiating instruction, providing incidental reading instruction to facilitate course objectives and to reduce failures, can be achieved to some extent by concerned teachers working alone or cooperating from time to time with a reading specialist. These objectives are the most immediate concerns of the classroom teacher. Working toward these objectives informally is a step to initiating and building support for SIRCA.

Higher in the taxonomy, the objectives become broader in scope, and require increasing involvement of the reading program resources within the content area classroom.

Recognition that reading is inseparable from content is the beginning point for an integrated multidisciplinary reading program. Screening for deficient readers clarifies the need, and can influence whatever ongoing reading instruction is established, in whatever way it is delivered.

SIRCA established in a content area enables systematic, prescriptive reading instruction and remediation within and through content courses. Stated in these terms, these objectives are primarily specialist concerns. However the SIRCA classroom teacher receives committed instructional support services from reading program resources, and is much better able to meet individual needs of all students. Content learning is enhanced by the application of competency-based methology.

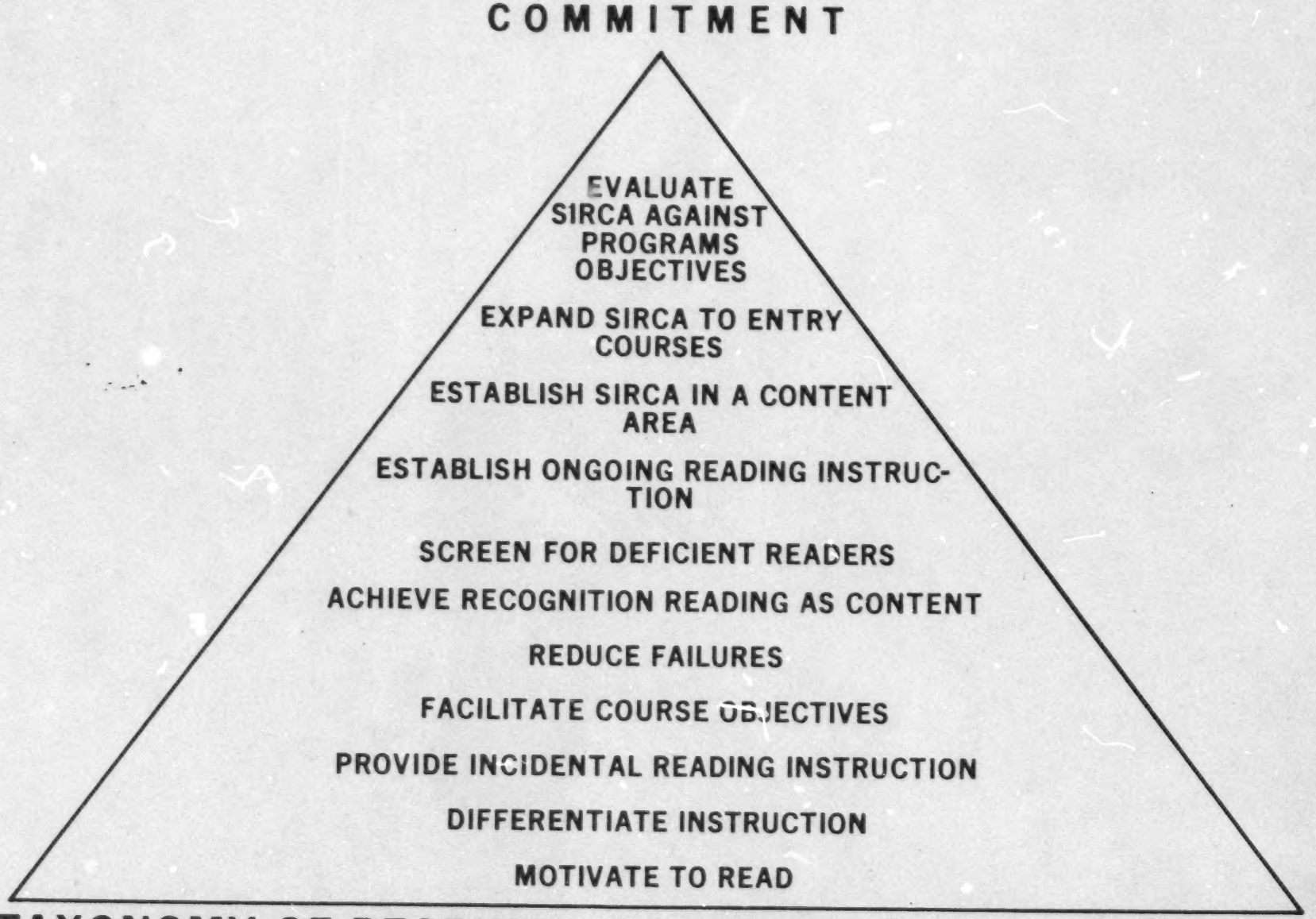
Expanding SIRCA to entry courses, for example all freshman science or social studies courses, makes available to every incoming student a full program of reading instruction.

Ultimately SIRCA must be evaluated against content area program objectives and reading program objectives. Criterion measures for these evaluations must be chosen, and a data base established.

The SIRCA objectives high in the taxonomy require increasing commitment of money,professional time, and administrative support. Yet the focusing of resources and the extraordinary involvement of content teachers in reading instruction create the possibility that a measurable difference in student reading abilities can be made.

SIRCA is a practical program design because it can be implemented in stages. A specialist can begin tentatively with the lower and more limited objectives on the taxonomy, and move to broader objectives as needs become apparent, and as confidence and support are generated within the school.

Table 5



TAXONOMY OF READING - IN - CONTENT-AREA OBJECTIVES

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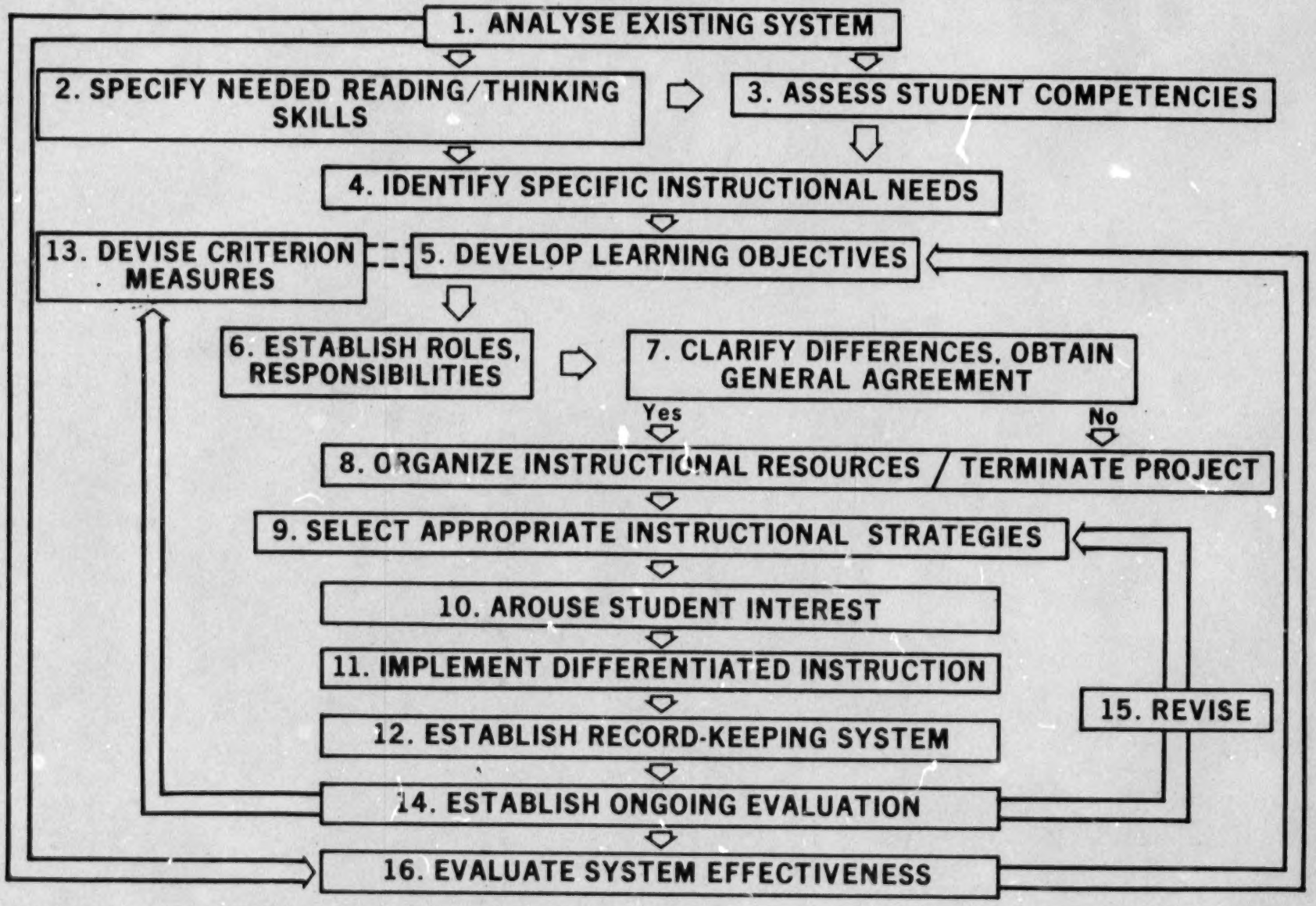
Summary

Table 6* summarizes the steps for implementing SIRCA within a content area class. The reading specialist talks informally with a classroom teacher to gain access to classes. Cloze testing is a good starting point for collaboration; teachers are interested in the findings, and the way is opened to consider the existing learning system, needed reading / thinking skills, and what can be done to develop them. Even if the project is terminated at this point, the reading specialist has gained valuable insight into one instructional situation in the school.

*Chart was adapted from a model in Davies, 2, p 28.

Table 6

SIRCA
STEPS FOR IMPLEMENTING the SYSTEM


1. ANALYSE EXISTING SYSTEM
2. SPECIFY NEEDED READING/THINKING SKILLS
3. ASSESS STUDENT COMPETENCIES
4. IDENTIFY SPECIFIC INSTRUCTIONAL NEEDS
13. DEVISE CRITERION MEASURES
5. DEVELOP LEARNING OBJECTIVES
6. ESTABLISH ROLES, RESPONSIBILITIES
7. CLARIFY DIFFERENCES, OBTAIN GENERAL AGREEMENT
Yes
No
8. ORGANIZE INSTRUCTIONAL RESOURCES / TERMINATE PROJECT
9. SELECT APPROPRIATE INSTRUCTIONAL STRATEGIES
10. AROUSE STUDENT INTEREST
11. IMPLEMENT DIFFERENTIATED INSTRUCTION
12. ESTABLISH RECORD-KEEPING SYSTEM
15. REVISE
14. ESTABLISH ONGOING EVALUATION
16. EVALUATE SYSTEM EFFECTIVENESS

CONCLUSION

Test evidence is not available at this writing to quantitatively evaluate SIRCA students' growth in earth science and reading abilities, although student, parent, and teacher reaction has been positive.

Participation in SIRCA has accomplished the inservice training of the earth science teacher in reading to an extent that is impossible in a traditional methods course, where the content teacher works alone to transfer reading theory to application in his / her own subject. The earth science course has been restructured, and a core of instructional options prepared, to provide ongoing instruction in reading / thinking processes. SIRCA has brought the reading specialist out of the laboratory into meaningful participation within the mainstream of school life. These are worthwhile achievements, likely to have continuing impact over time.

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